EXECUTIVE SUMMARY OF
ENERGY SURVEY
FOR
LYSTER ARMY COMMUNITY HOSPITAL
FT. RUCKER ARMY POST
DOTHAN, ALABAMA

PREPARED FOR:
MOBILE DISTRICT
U.S. ARMY CORPS OF ENGINEERS
MOBILE, ALABAMA

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EXECUTIVE SUMMARY

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I. INTRODUCTION

In August 1987, Energy Management Consultants, Inc. was retained by the Mobile District U.S. Army Corps of Engineers to perform an Energy Survey and an Energy Monitoring and Control System (EMCS) Feasibility Study for Lyster Army Community Hospital at Fort Rucker, Alabama.

The Energy Monitoring and Control System (EMCS) Feasibility Study was completed in March 1988. The EMCS for Lyster Army Community Hospital was subsequently designed by the Mobile District U.S. Army Corps of Engineers and is presently being installed at the hospital. Energy consumption in the hospital will be reduced 14.7 percent (in MBtus) as a result of implementing the EMCS.

This report summarizes results from the Energy Survey at Lyster Army Community Hospital. The purpose of this study is to identify Energy Conservation Opportunities (ECO's) at the facility which are technically and economically feasible. All analysis of ECO's included in this Energy Survey is based on the EMCS being installed and energy savings associated with the EMCS achieved.

The Scope of Work developed by the U.S. Army Corps of Engineers gave the following charge:

1. Perform a thorough audit of Lyster Army Community Hospital to become familiar with operations of the facility and all energy consuming equipment.

2. Compile building and system data obtained during the field survey. Actual system data, rather than design parameters, shall be utilized for the Energy Survey.

3. Utilize a computer program to incorporate local weather data, occupancy schedules, building construction data and equipment data into a model of the facility. The computer program analysis shall be based on an hour by hour simulation.

4. Evaluate the feasibility of a computer based Energy Monitoring and Control System (EMCS) for the facility.

5. Identify all reasonable and practical Energy Conservation Opportunities (ECO's) and perform calculations to determine economic feasibility.

6. Provide programming and implementation documentation for projects developed during the Energy Survey. Documentation shall include Project Development Brochures (PDBs) and DD form 1391.

7. Prepare a comprehensive report to document the work performed, results and recommendations.

The EMCS Feasibility Study, completed in March 1988, was addressed separate from the comprehensive Energy Survey of the hospital. Separation of these two projects was necessary to facilitate timely installation of the EMCS. The EMCS is presently being installed at Lyster Army Community Hospital.

Under direction of DEH at Fort Rucker, all recommended ECO's have been grouped into a single project for funding. This project is suitable for several funding programs (ECIP, OSD PIF, and PECIP). Overall totals for this group of ECO's is listed below.

ANNUAL ENERGY SAVINGS	1,326.70 MBtu - Natural Gas 4,385.67 MBtu - Electricity
ANNUAL ENERGY DOLLAR SAVINGS	$ 5,453.12 - Natural Gas $56,531.14 - Electricity
ANNUAL NON-ENERGY SAVINGS	$300.75
FIRST YEAR DOLLAR SAVINGS	$62,284.78
TOTAL INVESTMENT	$237,189.30
OVERALL SIR	2.35
SIMPLE PAYBACK	3.8 Years

Implementation of all ECO's included in the above project grouping will reduce energy consumption an additional 18.2 percent (in MBtus). Total energy reduction potential at the hospital from both the EMCS and ECO's recommended in the Energy Survey is 32.9 percent (in MBtus).

Table 1. Recommended ECO's, on the following page, presents energy savings and economic data on ECO's recommended for implementation at Lyster Army Community Hospital. In addition to the eight ECO's included in the above project grouping, one policy change is recommended, ECO 13-Reset Thermostats. This ECO analyzes economic benefits of maintaining temperatures according to interior mechanical design conditions for Army and Air Force medical facilities set forth in ETL-1110-3-344. Presently, all areas of the hospital are maintained at 72^{O}F throughout the year. ECO 13 will further reduce energy consumption by 3.5 percent (in MBtus). Total energy savings of 36.4 percent will therefore result from implementing the EMCS, recommended ECO's and the policy change.

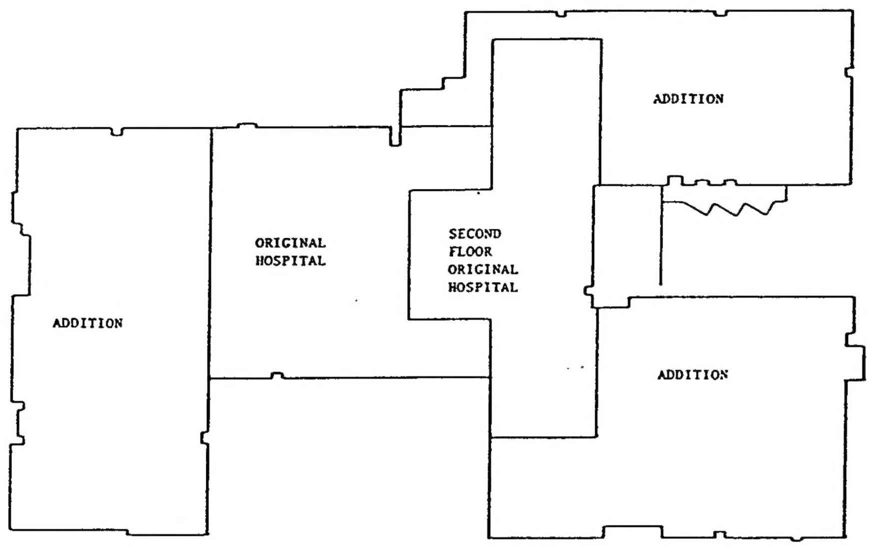
TABLE 1. RECOMMENDED ECO'S

MEASURE	ENERGY MBTUs	SAVINGS DOLLARS	TOTAL INVESTMENT	SIR	PAYBACK
ECO 2 Variable Speed Pumping	1,879.91	$24,232	$ 69,300	2.99	2.9
ECO 3 Two Speed Clg Tower Fan Motors	258.67	$3,334	$ 7,939	3.59	2.4
ECO 5 Reduce OSA AC-11, 13, 14	81.40	$561	$ 3,197	1.82	5.7
ECO 7 Convert Dual Duct to VAV	1,640.53	$19,590	$106,861	1.60	5.5
ECO 10 Reduce Supply Air - AC-3	473.43	$6,103	$ 7,868	6.62	1.3
ECO 11 Automatic Tube Cleaners	104.64	$1,349	$ 14,213	1.00	8.6
ECO 12 Chiller Aux Condenser	1,103.16	$5,759	$ 21,870	3.86	3.8
ECO 14 Window Shading	170.63	$1,056	$ 5,943	1.39	5.6
SUB-TOTALS	5,712.37	$61,984	$237,189	2.35	3.8
ECO 13 Policy Change Reset Thermostats	1,088.10	$14,170	$ 101	932.33	0.01
TOTALS	6,800.47	$76,154	$237,290	2.86	3.1

II. BUILDING DATA

Lyster Army Community Hospital, Building 301 located at Fort Rucker, Alabama, is a 72 bed total health care facility. This hospital was constructed under two contracts, the original 65,480 square foot hospital and a 141,240 square foot addition which also included a major renovation of the original hospital. Figure 1. Hospital Layout indicates areas constructed originally and during the 1981 Additions and Renovations.

FIGURE 1. HOSPITAL LAYOUT



Hospital construction consists of a concrete slab floor and concrete/masonry exterior walls with fibrous insulation. The original hospital has a concrete roof deck with membrane and built up type roofing and single glazed windows. The addition construction has a metal roof deck with built up roofing and double glazed windows. All building envelope components, except for the single glazed widows, have excellent thermal properties.

Lighting systems in use at this facility primarily consist of energy efficient fluorescent fixtures. Lighting density ranges from 0.7 watts/square foot to 1.8 watts/square foot. Critical areas such as surgery suites have higher lighting densities.

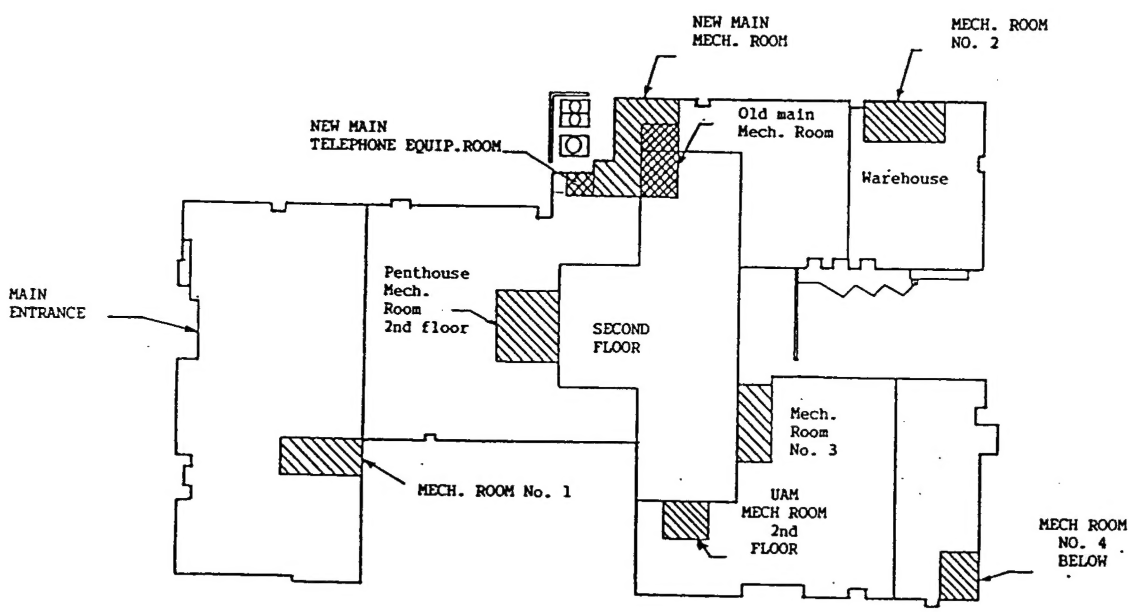
Domestic hot water is provided by steam from the basewide steam distribution system which is supplied to storage tanks with internal steam converters. The two (2) storage tanks in the original hospital have 250 gallons storage capacity which is used in all of the original hospital areas. The 400 gallon storage tank provides domestic hot water

for all areas included in the 1981 addition. Water temperature is maintained at 115 degrees F. Booster heaters are used for kitchen equipment which requires 140 and 180 degree F water.

Heating Ventilating and Air Conditioning (HVAC) for this facility is provided by three (3) water cooled centrifugal chillers, two (2) rated at 230 tons and one (1) rated at 360 tons, steam provided by the basewide steam distribution system, and associated pumps and hot water converters. Air systems located throughout the hospital include eight (8) multizone air handling units (AHUs), two (2) dual duct AHUs, two (2) single zone AHUs. one (1) multizone-reheat system and one (1) Unitized Air Module (UAM) which has a chilled water coil. Two pipe fan coil units (FCUs) are used to condition patient rooms.

Figure 2. Major Equipment Rooms, below, is a hospital layout which illustrates location of all major equipment rooms. Table 2. Equipment List, which follows Figure 2., identifies major HVAC equipment, location, type, capacity and area serviced by the system or component.

FIGURE 2. MAJOR EQUIPMENT ROOMS



BUILDING NO. 301
LYSTER ARMY COMMUNITY HOSPITAL

TABLE 2. EQUIPMENT LIST

EQUIPMENT	LOCATION	TYPE	CAPACITY	AREA SERVED
CHILLERS				
Chiller #1	Main Mech	Centrifugal	230 tons	Hospital
Chiller #2	Main Mech	Centrifugal	230 tons	Hospital
Chiller #3	Main Mech	Centrifugal	360 tons	Hospital
PUMPS				
CHW #1	Main Mech	Centrifugal	960 GPM	Chiller #1 Chiller #2
CHW #2	Main Mech	Centrifugal	960 GPM	Chiller #1 Chiller #2
P-1	Main Mech	Centrifugal	660 GPM	Chiller #1
P-1	Main Mech	Centrifugal	660 GPM	Chiller #2
P-2	Main Mech	Centrifugal	1,044 GPM	Chiller #3
P-3	Main Mech	Centrifugal	900 GPM	Chiller #3
TRANSFORMER				
Substation	Main Mech	Double Ended	2,000 KVA	Hospital
COOLING TOWERS				
CT-1	Main Mech	Crossflow	230 tons	
CT-2	Main Mech	Crossflow	230 tons	
CT-3	Main Mech	Crossflow	360 tons	
AIR HANDLING UNITS				
AC-2	Penthouse	DD	22,800 CFM	X-Ray, Surgical Clinic, Food Services
AC-3	Penthouse	DD	22,500 CFM	EENT, Phys. Therapy, Dental, Administration
AC-7	Mech #1	MZ	17,040 CFM	Pediatrics, Family Practice, Medical Records, Pharmacy
AC-8	Mech #1	MZ	18,360 CFM	OB/GYN, Social Services, Internal Medicine
AC-9	Mech #1	MZ	9,855 CFM	Laboratory
AC-10	Roof	SZ	2,875 CFM	Emergency Room
AC-11	Mech #2	MZ	14,560 CFM	CMS, Bio-med Food Service Morgue
AC-12	ICU	SZ	18,365 CFM	ICU
AC-13	Mech #3	MZ	14,075 CFM	Command, Admin, Nursing

TABLE 2. EQUIPMENT LIST (CONTINUED)

EQUIPMENT	LOCATION	TYPE	CAPACITY	AREA SERVED
AIR HANDLING UNITS (CONTINUED)				
AC-14	Mech #3	MZ	11,860 CFM	Phys. Exam, Aviation Med.
AC-16	Mech #4	MZ	8,060 CFM	Aero Medical
AC-17	Mech #4	MZ	13,200 CFM	Aero Medical
AC-19	Telephone Room	SZ	2,000 CFM	Telephone Room
AC-20	Penthouse	MZRH	10,855 CFM	Surgery, OB
HEAT WHEEL				
UAM	UAM Mech	With CHW Coil	18,365 CFM	2nd Floor, 100% Outside Air
HEW-1	Mech #1		13,070 CFM	AC-7, AC-8, AC-9
HOT WATER CONVERTERS				
HEX-1	Mech #1	Steam	78 GPM	AC-7, AC-8, AC-9, AC-10
HEX-2	Mech #2	Steam	42 GPM	AC-11, AC-15, HV-3
HEX-3	Mech #3	Steam	61 GPM	AC-13, AC-14
HEX-4	Mech #4	Steam	36 GPM	AC-16, AC-17
Reheat	Penthouse	Steam	34 GPM	AC-20
FAN COILS				
East	Penthouse	Two-Pipe	45 GPM	Patient Rooms
West	Penthouse	Two-Pipe	45 GPM	Patient Rooms
CONTROL AIR				
New	Penthouse		15 PSIG	New Additions
Old	Penthouse		15 PSIG	Old Hospital
UAM	UAM		15 PSIG	UAM
MASTER OSA TEMPERATURE	UAM Mech			All MUX's

III. PRESENT ENERGY CONSUMPTION

Energy at Fort Rucker is primarily provided by electricity from Alabama Power Company and natural gas from Southeast Alabama Gas District.

The primary electricity service to the hospital is from the base system that is supplied at a single point from the 500 kv Alabama Power Company distribution system. Even though the hospital is submetered, there is no accurate profile of electricity used at the hospital. Analysis of submetered data made available from DEH indicated obvious inconsistencies. One month would indicate consumption of 100,000 kwh in the hospital and the next month would indicate consumption of 1,000 kwh. This data was therefore not used.

The hospital is supplied with 85 PSIG steam from the basewide steam distribution system. Steam enters the hospital in the main mechanical room and is distributed to cooking, sterilization, domestic hot water and heating equipment throughout the hospital.

The two 600 kw diesel powered emergency generators are used to reduce demand during peak load conditions and to provide power to hospital systems during power failure. These generators are started only when critical hospital operations will not be affected. The generators are brought on line at least once each month and when new demand peaks are set for the main basewide electricity account to shave demand charges. No historical data was available for diesel fuel consumption. This energy has not been included in the analysis. Only electrical energy consumption has been addressed.

DERIVATION OF ENERGY COSTS

The natural gas energy costs for the hospital are based on the 12 month billing histories of the main basewide gas account. The average cost per MCF for the past 12 months is used since the price paid varies from month to month depending upon the cost of gas to the supplier. This average cost is:

$$\frac{\text{12 mo. Cost}}{\text{12 mo. Use}} = \frac{\$2{,}177{,}479.94}{\text{5,256,750 CCF}} = \$0.4142 \text{ per CCF}$$

Cost per therm:

\$/CCF x 12 mo avg Btu adj x CCF/Btu x Btu/Therm = \$/Therm

\$0.4142/CCF x 1.0227 x 1 CCF/103,000 Btu x 100,000 Btu/Therm

= \$0.4113 per therm

DERIVATION OF ENERGY COSTS (CONTINUED)

Cost per million Btu ($/MBtu):

$$\$/\text{MBtu} = \frac{\$0.4113}{\text{Therm}} \times \frac{10\ \text{Therm}}{\text{MBtu}} = \$4.113/\text{MBtu}$$

The electrical demand and energy costs are based on the main service to Fort Rucker billed on the LPL Rate Schedule. The average cost of electricity is used to compute annual cost savings. The average cost/kwh is calculated as follows:

Cost per kwh ($/kwh):

$$\frac{12\ \text{mo total bill}}{12\ \text{mo kwh usage}} = \frac{\$4{,}747{,}090.37}{107{,}856{,}000\ \text{kwh}} = \$0.04401/\text{kwh}$$

Cost per million Btu ($/MBtu):

$$\$0.04401/\text{kwh} \times \frac{1\ \text{kwh}}{3{,}413\ \text{Btu}} \times \frac{1{,}000{,}000\ \text{Btu}}{\text{MBtu}} = \$12.89/\text{MBtu}$$

ENERGY CONSUMPTION SIMULATION

Energy consumption was simulated using the Trane TRACE (Trane Air Conditioning Economics) computer program since an accurate energy consumption profile for the hospital is not available. No attempt was made to include energy consumption by the exterior lighting, elevators, sterilizers, kitchen equipment or altitude chamber equipment since no ECO's would be applicable to these systems. This makes the baseline energy consumption and cost rates of 151,775 Btus/sq.ft./yr. and $1.576/sq.ft./yr., respectively, seem low. Most of this energy, however, is used for HVAC system operation and interior lighting, therefore, this number is reasonable. The sensible and latent energy of the loads not included in the TRACE program were accounted for in the cooling load estimates but not in the electricity or natural gas consumption. This approach was approved by the Mobile District U.S. Army Corps of Engineers.

The baseline annual energy consumption computed by TRACE is :

6,555,243 kwh	22,373.04 MBtus
90,018 therms	9,001.80 MBtus

Figure 3. Energy Distribution graphically illustrates consumption in Btus for each major energy using component. This graph indicates the large amount of energy consumed by HVAC system components, especially pumps and air system fans. Figure 3a. Energy Cost Distribution graphically illustrates consumption in dollars for each major energy using component.

FIGURE 3. ENERGY DISTRIBUTION

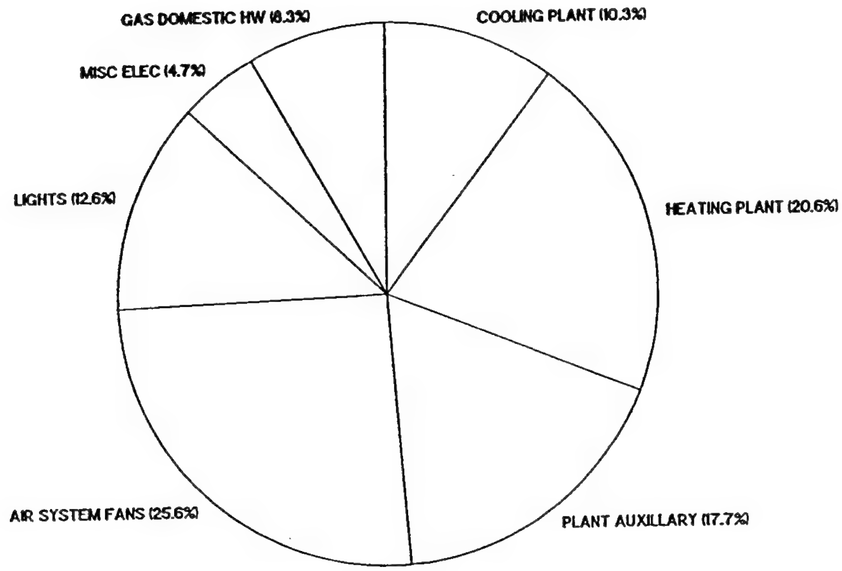


FIGURE 3a. ENERGY COST DISTRIBUTION

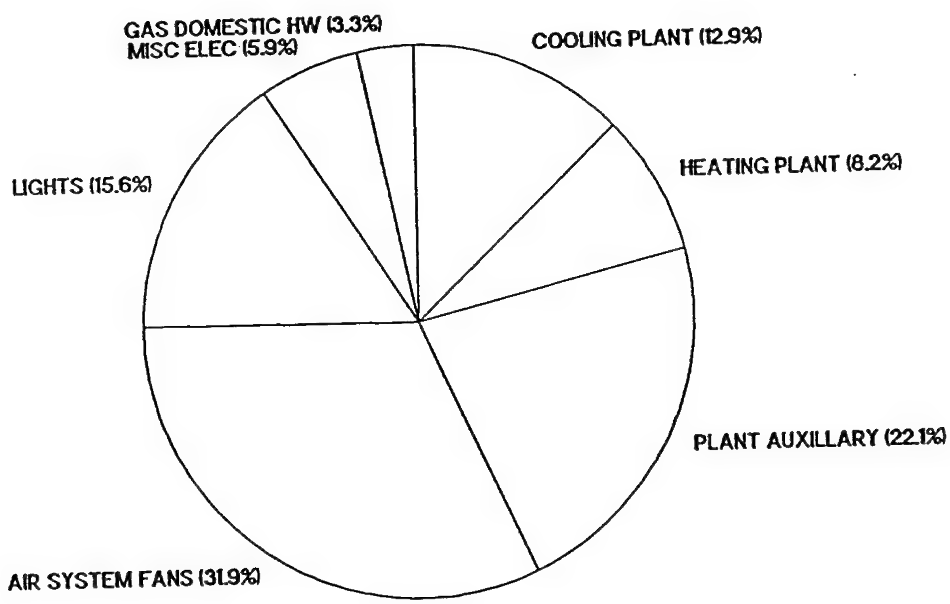


Figure 4. and Figure 5. are graphical illustrations of electrical energy consumption in kilowatt-hours (kwh) and demand in kilowatts (kw) on a monthly basis for the loads simulated in the TRACE analysis. These figures illustrate that peak electrical energy requirements occur during summer months when cooling loads are at maximum levels.

FIGURE 4. MONTHLY ELECTRICAL ENERGY CONSUMPTION

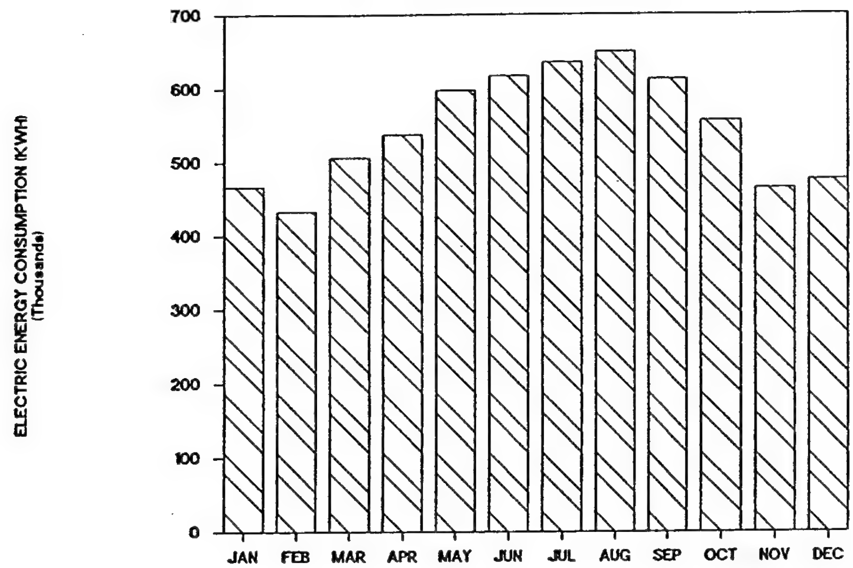
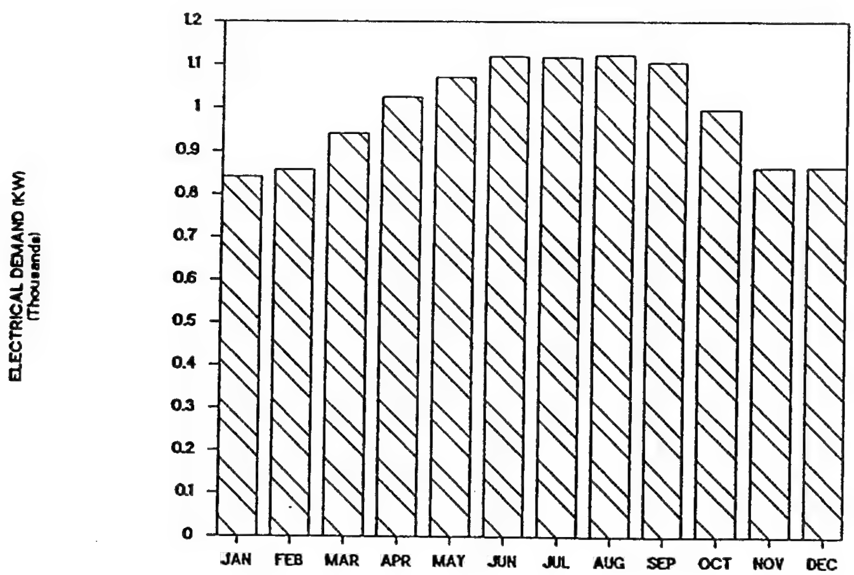


FIGURE 5. MONTHLY ELECTRICAL DEMAND



Monthly natural gas consumption for heating, reheat, humidification and domestic hot water is represented graphically in Figure 6. The base load requirements for domestic water heating and reheat is illustrated by relatively constant consumption between May and September. Peak consumption occurs during January when heating requirements in the hospital are at a maximum level.

FIGURE 6. MONTHLY NATURAL GAS ENERGY CONSUMPTION

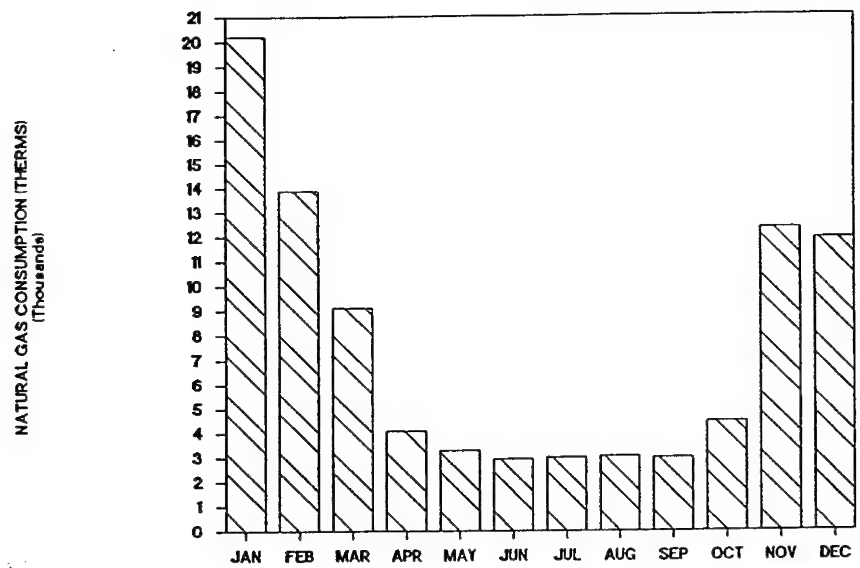
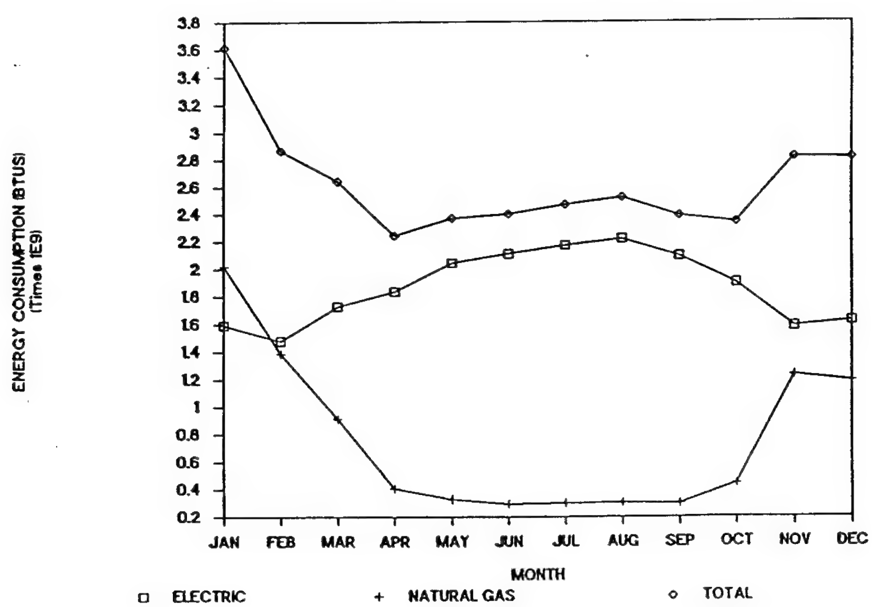


Figure 7 is a graphical representation, on a monthly basis, of the energy consumption at the hospital by fuel type for the loads simulated with TRACE.

FIGURE 7. MONTHLY ENERGY CONSUMPTION BY FUEL TYPE



IV. ENERGY MONITORING AND CONTROL SYSTEM

As previously mentioned in the Introduction section of this report, Scope of Work, Item 4 required evaluation of the feasibility of a computer based Energy Monitoring and Control System (EMCS) for the facility.

An Energy Monitoring and Control System is an energy management system which employs a computer to effect energy and manpower savings, primarily for HVAC and lighting. The EMCS may also be used to assist in building maintenance management. This system would perform scheduled stop/start, optimum stop/start, night setback, ventilation recirculation and hot/cold deck reset.

This feasibility study has been completed and accepted. Design of the EMCS was performed by the Mobile District U.S. Army Corps of Engineers and the system is presently being installed. This study also identified $24,125 worth of calibration and repair work that must be accomplished prior to the installation of an EMCS. It is very important that local loop controls operate properly because the EMCS cannot function properly without them.

The energy savings calculations for the initial study were performed using TRACE II. The TRACE II model is considered a good first approximation of the hospital HVAC energy consumption. This TRACE II model was converted to a full TRACE model for this Energy Survey. All Energy Conservation Opportunities (ECOs) studied in this survey are based on the EMCS being installed. The baseline energy consumption for the hospital with an operable EMCS is:

5,597,122 kwh	19,102.98 MBtus
76,583 therms	7,658.30 MBtus

This represents a new energy consumption rate for conditioned areas of 129,457 Btus/sq.ft./year for the loads modeled by TRACE. This represents annual energy savings (in Btus) of 14.7 percent as a result of the EMCS. Figure 8. Energy Distributions with EMCS graphically illustrates consumption in Btus for each major energy using component with an operable EMCS. Figure 9. EMCS Savings by Component illustrates Btu savings for each HVAC system component. Figure 8a. Energy Cost Distribution with EMCS graphically illustrates consumption in dollars for each major energy using component with an operable EMCS. Figure 9a. EMCS Cost Savings Distribution by Component illustrates dollar savings for each HVAC system component.

FIGURE 8. ENERGY DISTRIBUTION WITH EMCS

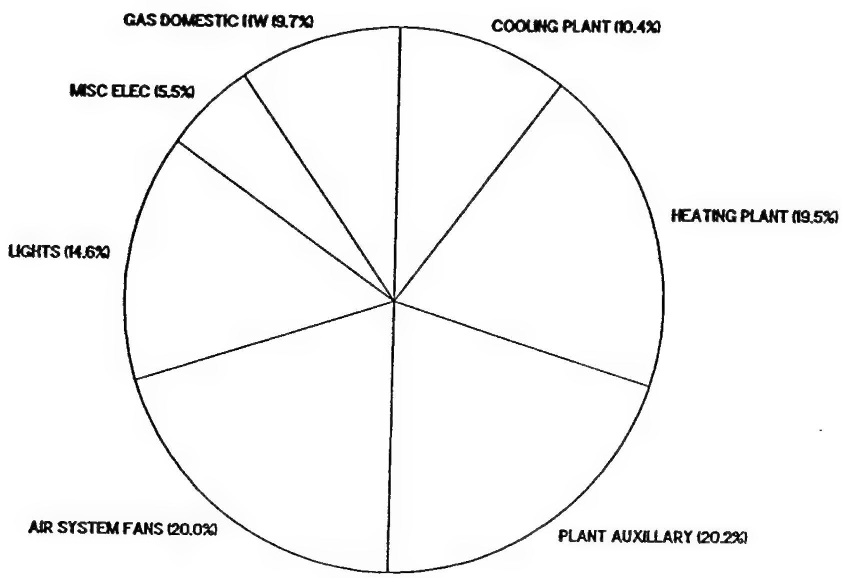
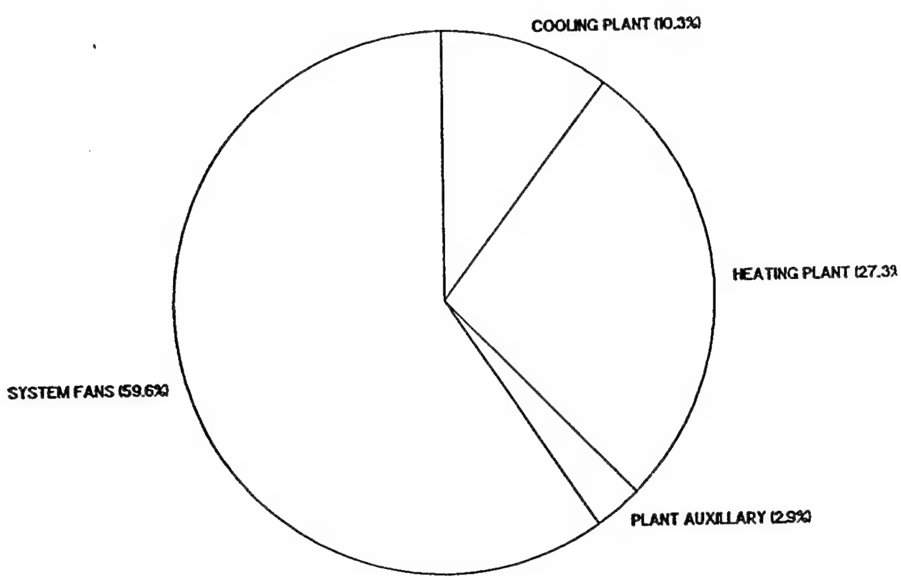


FIGURE 9. EMCS SAVINGS BY COMPONENT



This graph indicates that savings from reducing fan operation will provide nearly 60 percent of the total savings from the EMCS.

FIGURE 8a. ENERGY COST DISTRIBUTION WITH EMCS

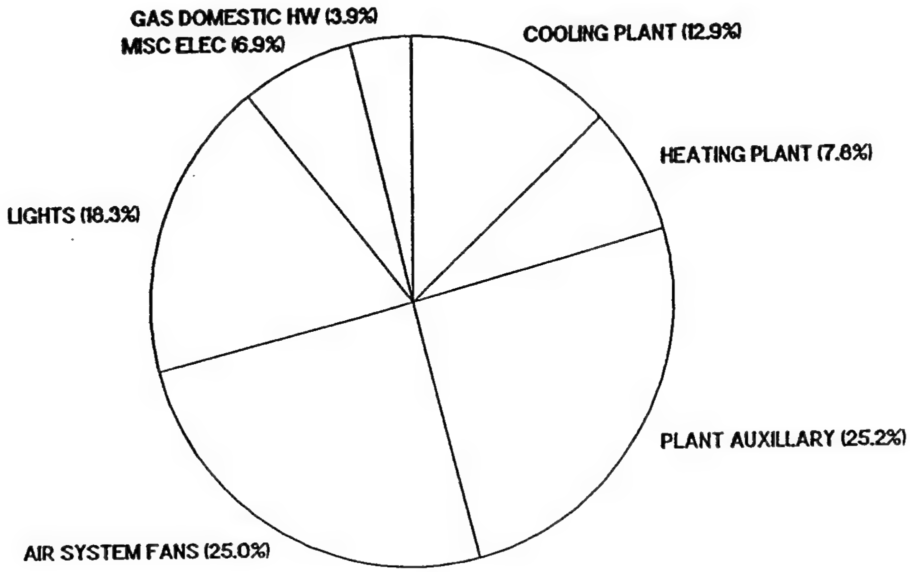
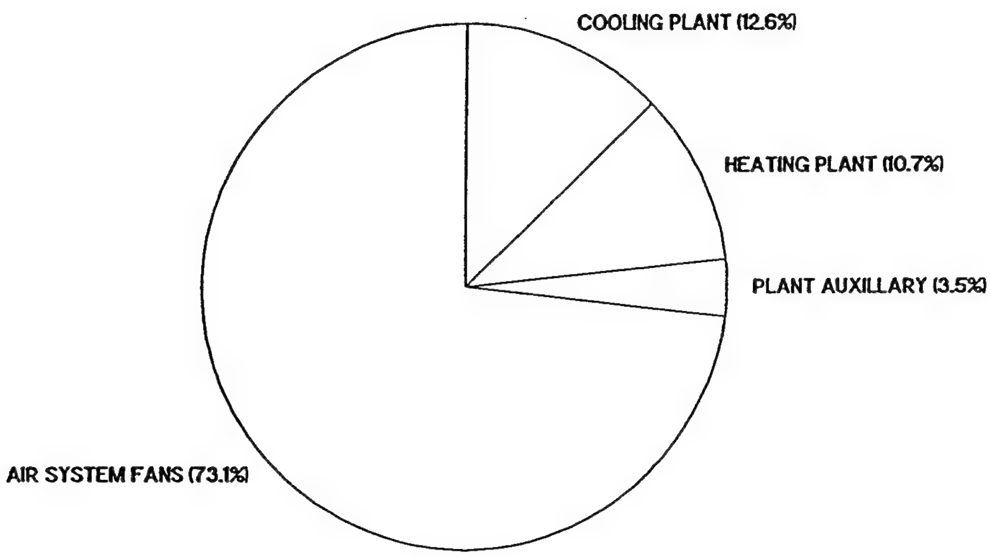


FIGURE 9a. EMCS COST SAVINGS DISTRIBUTION BY COMPONENT



This graph indicates that savings from reducing fan operation will provide over 73 percent of this total savings from the EMCS.

V. ENERGY CONSERVATION ANALYSIS

The following ECOs were evaluated for Lyster Army Community Hospital. After a brief description of each ECO, results are indicated. ECOs which have a Savings to Investment Ratio (SIR) greater than or equal to one (1) are recommended for implementation. A detailed summary of all analyzed ECO's is included in Attachment B. Recommended ECO's ranked by SIR, are summarized in Attachment C. Items identified on the Energy Conservation Opportunities Checklist, included in the Scope of Work, are included in Attachment A.

ECO 1. Reset Thermostat Setting - AC-10

This ECO, recommended in the Pre-final Submittal, evaluated installation of a self contained thermostatic diffuser in the ambulance dispatch area to eliminate overcooling the adjacent Emergency Room during peak cooling conditions. AC-10, a single zone AHU, currently serves both areas. This unit does not have adequate cooling capacity for the loads associated with these areas. Energy savings will therefore not result from the use of a thermostatic diffuser in the ambulance dispatch area. This ECO is not recommended.

ECO 2. Variable Speed Pumping

This ECO evaluated converting the existing chilled water system to a primary/secondary loop system and using a variable frequency drive (VFD) to accomplish variable water flow rates in the secondary loop. Chilled water flow in the secondary loop will vary according to the cooling requirements in the building.

ANNUAL ENERGY SAVINGS (MBTU)	
ELECTRICITY	1,879.9
NATURAL GAS	0.0
FIRST YEAR DOLLAR SAVINGS	$24,232
TOTAL INVESTMENT	$69,300
SIMPLE PAYBACK (YEARS)	2.9
SIR	2.99

ECO 3. Two Speed Motor for Cooling Tower

This ECO evaluated converting the existing single speed cooling tower fan to a two speed fan by installing a two speed motor and associated controls. Fan speed will be controlled to maintain a constant leaving condenser water temperature. Fan speed will then vary according to the cooling requirements in the building.

ANNUAL ENERGY SAVINGS (MBTU)	
ELECTRICITY	259.0
NATURAL GAS	0.0
FIRST YEAR DOLLAR SAVINGS	$3,334
TOTAL INVESTMENT	$7,939
SIMPLE PAYBACK (YEARS)	2.4
SIR	3.59

ECO 4. Double Pane Windows

This ECO evaluated replacing single pane windows with double pane windows. Single pane windows are located on the entire second floor, and the following areas on the first floor: X-Ray, Surgery Clinic, Orthopedic Clinic, the Kitchen, Administration, Physical Therapy,Dental Clinic and EENT Clinic.

ANNUAL ENERGY SAVINGS (MBTU)	
ELECTRICITY	50.5
NATURAL GAS	150.8
FIRST YEAR DOLLAR SAVINGS	$1,271
TOTAL INVESTMENT	$30,156
SIMPLE PAYBACK (YEARS)	23.7
SIR	0.45

ECO 5. Reduce Outside Air - AC-11, AC-13,and AC-14

This ECO evaluated reduction of outside air quantity for AC-11, AC-13, and AC-14. The existing quantity of outside air for areas served by these units exceeds Army medical facility outside air

ECO 5. Reduce Outside Air - AC-11, AC-13, and AC-14 (Continued)

ventilation requirements.

ANNUAL ENERGY SAVINGS (MBTU)

ELECTRICITY	25.8
NATURAL GAS	55.6
FIRST YEAR DOLLAR SAVINGS	$561
TOTAL INVESTMENT	$3,197
SIMPLE PAYBACK (YEARS)	5.7
SIR	1.82

ECO 6. Reduce Outside Air to Operating Rooms

This ECO, recommended in the Interim Submittal, evaluated reduction of outside air quantity for AC-20, which serves operating rooms and surrounding areas, to five air changes per hour. This minimum outside air was taken from Table 8-1 of TM 5-838-2. The air that would have been recirculated is from patient rooms and soiled utility rooms. This air can not be recirculated. **Reduce outside air to operating rooms violates TM-5-838-2 and is therefore not recommended.**

ECO 7. Convert Dual Duct Units to Variable Air Volume

This ECO evaluated converting two (2) high pressure dual duct air systems (AC-2 and AC-3) to variable air volume (VAV). The existing system mixes hot air and cold air from two (2) separate ducts (dual duct) to satisfy thermostat setpoints for each zone. This system conversion will prevent excessive reheating to satisfy zone comfort requirements.

ANNUAL ENERGY SAVINGS (MBTU)

ELECTRICITY	1,436.2
NATURAL GAS	177.3
FIRST YEAR DOLLAR SAVINGS	$19,590
TOTAL INVESTMENT	$106,861
SIMPLE PAYBACK (YEARS)	5.5
SIR	1.60

ECO 8. <u>Convert Multi-zone Units to Variable Air Volume</u>

This ECO evaluated converting eight (8) low pressure multi-zone air systems (AC-7, AC-8, AC-9, AC-11, AC-13, AC-14, AC-16, and AC-17) to variable air volume (VAV). The existing system mixes hot air and cold air at the AHU to satisfy thermostat setpoints for each zone. This system conversion will prevent excessive reheating to satisfy zone comfort requirements.

ANNUAL ENERGY SAVINGS (MBTU)	
ELECTRICITY	842.6
NATURAL GAS	368.9
FIRST YEAR DOLLAR SAVINGS	$12,377
TOTAL INVESTMENT	$132,784
SIMPLE PAYBACK (YEARS)	10.7
SIR	0.85

ECO 9. <u>Unoccupied Setback of Operating and Delivery Rooms</u>

This ECO evaluated reduction of supply air provided to operating and delivery rooms when the space is not in use. This retrofit will involve using occupancy sensors to control two position dampers in each room and a variable frequency drive to reduce fan speed when full load operation is not necessary to maintain space temperature requirements. Only three (3) air changes per hour of outside air is required when these areas are unoccupied. Currently, fifteen (15) air changes per hour of outside air is supplied to these rooms continuously.

ANNUAL ENERGY SAVINGS (MBTU)	
ELECTRICITY	82.2
NATURAL GAS	206.6
FIRST YEAR DOLLAR SAVINGS	$1,909
TOTAL INVESTMENT	$22,515
SIMPLE PAYBACK (YEARS)	11.3
SIR	0.94

ECO 10. Reduce Supply Air - AC-3

This ECO evaluated installation of a two speed 50/22 HP fan motor for AC-3 to replace the existing sixty (60) HP fan motor. The existing supply air volume exceeds the necessary air volume required to condition the areas served.

ANNUAL ENERGY SAVINGS (MBTU)	
ELECTRICITY	473.4
NATURAL GAS	0.0
FIRST YEAR DOLLAR SAVINGS	$6,103
TOTAL INVESTMENT	$7,868
SIMPLE PAYBACK (YEARS)	1.29
SIR	6.62

ECO 11. Automatic Tube Cleaners

This ECO evaluated installation of automatic tube cleaners for one 230 ton centrifugal chiller. These tube cleaners automatically clean scale from the heat transfer tubes throughout the year. The existing maintenance schedules called for annual cleaning which reduced chiller efficiency and increased energy consumption throughout the year.

ANNUAL ENERGY SAVINGS (MBTU)	
ELECTRICITY	104.6
NATURAL GAS	0.0
FIRST YEAR DOLLAR SAVINGS	$1,650
TOTAL INVESTMENT	$14,213
SIMPLE PAYBACK (YEARS)	8.6
SIR	1.00

An annual maintenance dollar savings of $301 is included in First Year Dollar Savings for automatic tube cleaners.

ECO 12. Chiller Auxiliary Condenser

This ECO evaluates installation of an auxiliary condenser for heat recovery from one of the 230 ton centrifugal chillers. The heat recovered will be used for domestic hot water (DHW) preheat. This

ECO 12. Chiller Auxiliary Condenser (Continued)

measure will also increase chiller efficiency by increasing condenser heat transfer surface area and lowering pressure differential required by the compressor.

ANNUAL ENERGY SAVINGS (MBTU)	
ELECTRICITY	139.6
NATURAL GAS	963.6
FIRST YEAR DOLLAR SAVINGS	$5,759
TOTAL INVESTMENT	$21,870
SIMPLE PAYBACK (YEARS)	3.8
SIR	3.86

ECO 13. Reset All Thermostats

This ECO evaluated resetting thermostatic temperature settings throughout the hospital. Currently thermostats throughout the hospital are set at 72°F. Interior mechanical design conditions for Army and Air Force medical facilities, ETL-1110-3-344, require occupied thermostatic setpoints that range from 68°F to 75°F for heating and 75°F to 78°F for cooling. This ECO is a policy change recommendation.

ANNUAL ENERGY SAVINGS (MBTU)	
ELECTRICITY	1,104.6
NATURAL GAS	(16.5)
FIRST YEAR DOLLAR SAVINGS	$14,170
TOTAL INVESTMENT	$101
SIMPLE PAYBACK (YEARS)	0.01
SIR	932.33

ECO 14. Window Shading

This ECO evaluated installation of exterior mounted screens on all single pane windows which presently do not have tint. The screens will reduce cooling loads associated with solar heat gain. Installation of these screens will also reduce heating requirements

ECO 14. <u>Window Shading (Continued)</u>

since window resistance to heat loss will be increased.

ANNUAL ENERGY SAVINGS (MBTU)	
ELECTRICITY	40.4
NATURAL GAS	130.2
FIRST YEAR DOLLAR SAVINGS	$1,056
TOTAL INVESTMENT	$5,943
SIMPLE PAYBACK (YEARS)	5.6
SIR	1.39

VI. SUMMARY

Implementation of all ECOs found to be economically feasible as a result of the Energy Survey for Lyster Army Community Hospital and the policy change recommended in ECO 13, Reset Thermostats, will result in the following energy and cost savings, investment, payback period, and overall SIR.

ANNUAL ENERGY SAVINGS	1,310.20 MBtu - Natural Gas 5,490.27 MBtu - Electricity
ANNUAL ENERGY DOLLAR SAVINGS	$ 5,384.92 - Natural Gas $70,769.58 - Electricity
ANNUAL NON-ENERGY SAVINGS	$300.75
FIRST YEAR DOLLAR SAVINGS	$76,455.25
TOTAL INVESTMENT	$237,289.60
OVERALL SIR	2.86
SIMPLE PAYBACK	3.1 Years

Resulting energy consumption after implementation of all recommended ECOs will be:

3,988,486 kwh	13,612.71 MBtus
63,481 therms	6,348.10 MBtus

This represents a new energy consumption rate of 96,560 Btus/sq.ft./year for the loads modeled by TRACE. This represents energy savings (in Btus) of 36.4 percent from the initial baseline consumption rate of 151,775 Btus/sq.ft./year (baseline prior to EMCS). Total energy consumption reduction for the ECOs recommended in the Energy Survey represents 21.7 percent of the total potential savings. The remaining 14.7 percent will result from the EMCS which is currently being installed at the hospital.

ATTACHMENT A

ENERGY CONSERVATION OPPORTUNITIES CHECKLIST

The Energy Conservation Opportunities Checklist was included in the Scope of Work for the Energy Survey at Lyster Army Community Hospital. This list defines typical Energy Conservation Opportunities (ECO's) for various building energy consuming systems. All items were addressed specifically to the operation and facilities of Lyster Army Community Hospital. Responses follow each item included in the checklist.

<u>Heating, Ventilating, and Air Conditioning</u>

1. Shut off air handling units whenever possible

   Setback of equipment is included in the EMCS.

2. Reduce outside air intake when the air must be heated or cooled before use.

   Existing economizers are in use. Reduction of ventilation rates examined. (ECO-5)

3. Reduce volume of air circulated through air handling units.

   Variable air volume operation is analyzed for both dual duct and multizone air handling units. (ECOs 7 & 8)

4. Shut off or reduce speed of room fan coils.

   This measure is provided for in the EMCS for larger air systems. Fan coils, located in patient rooms are not applicable (NA).

5. Shut off or reduce stairwell heating.

   Not Applicable (NA)

6. Shut off unneeded circulating pumps.

   No excessive operation of pumps was noted in the field.

7. Reduce humidification to minimum requirements.

   Humidification levels are acceptable.

8. Reduce condenser water temperature.

   Savings from variable speed cooling tower fans is optimum at design condenser water temperature of $85^{o}F$.

9. Cycle fans and pumps.

   Fan cycling violates air change requirement. Pump cycling is not feasible with continuous cooling load and variable speed pumping.

10. Reduce pumping flow.

   Pump impellers will be trimmed in variable pumping ECO (ECO 2).

11. Reset thermostats higher during cooling and lower during heating.

   See ECO 13

12. Repair and maintain steam lines and steam traps.

   No steam leaks or faulty traps were noted.

13. Use damper controls to shut off air to unoccupied areas.

   Outside air setback to operating rooms will be examined (ECO 6).

14. Reset hot and cold deck temperatures based on areas with greatest need.

   Some AHUs have discriminators; however such controls were noted in the EMCS study as being in disrepair. Controls on the major systems will be evaluated in the two VAV ECOs (#8).

15. Raise chilled water temperature.

   Elevated chilled water temperatures reduce humidity control and are not recommended. Recommended ECO's, such as VAV conversions and variable speed pumping work best with normal chilled water temperatures. Chilled water reset was analyzed in the EMCS Feasibility Study and found to not be feasible with annual cost savings of $457 resulting in an SIR of 0.93.

16. Shed loads during peak electrical use periods.

   The Emergency Generator is presently being utilized for peak electrical use periods to shave demand charges.

17. Use outside air for free cooling whenever possible. (Dry bulb economizers)

   Enthalpy economizers are existing.

18. Reduce reheating of cooled air.

    This action covered in the context of analysis of VAV (ECOs 7 & 8).

19. Recover heating or cooling with energy recovery units.

    Existing heat recovery units are in operation. Chiller heat recovery addressed in ECO 12.

20. Reduce chilled water circulated during light cooling loads.

    Variable pumping ECO is evaluated (ECO 2)

21. Install minimum sized motor to motor loads.

    A smaller motor is recommended for AC-3. (ECO 10)

22. Replace hand valves with automatic controls.

    Not Applicable (NA)

23. Install variable air volume controls.

    Variable air volume operation will be analyzed for both dual duct and multizone air handling units. (ECOs 7 & 8)

24. Insulate ducts and piping.

    Insulation is adequate.

25. Eliminate simultaneous heating and cooling.

    Simultaneous heating and cooling will be minimized in VAV operation (ECOs 7 & 8).

26. Install night setback controls.

    Setback is provided in EMCS.

27. Clean coils.

    Maintenance at Lyster Army Community Hospital is excellent. Coils are cleaned on an periodically depending on need. No debris build-up was noted on coils while performing site survey.

28. Maintain filters.

    Maintenance at Lyster Army Community Hospital is excellent. Filters are replaced every three months.

29. Repair and/or maintain air handling controls.

    Repair of controls was recommended in EMCS study.

30. Multispeed/variable speed cooling tower fans.

    This ECO is evaluated (ECO 3).

31. Chiller optimization.

    NA

32. Common manifolding of chillers.

    Installation of primary and secondary chilled waterloops will be implemented in the variable pumping ECO (ECO 2).

33. Automatic chiller tube cleaner.

    Automatic chiller tube cleaners are evaluated in ECO 12

Lighting

1. Shut off lights when not needed.

   Building officials indicate that manual setback of lighting is effective.

2. Reduce lighting levels.

   Recent renovation optimized lighting systems

3. Revise cleaning schedules.

   NA

4. Convert to energy efficient systems.

   Recent renovation optimized lighting systems

Building Envelope

1. Reduce infiltration by caulking and weatherstripping.

   No problems with infiltration were noted in the field.

2. Install insulated glass or double glazed windows.

   Most areas have insulated glass. Areas that don't were examined and found not to be economically feasible.

3. Install roof insulation.

   NA - Removed from scope

4. Install loading dock seals.

   NA

5. Install vestibules on entrances.

   Vestibules currently exist.

6. Reduce window heat gain by solar shading, screening, curtains, or blind.

   Curtains and blinds already exist. Installation of exterior screens is addressed for single pane windows with no tinting (ECO 14).

7. Install wall insulation.

   Wall insulation already exists at adequate levels.

<u>Electrical Equipment</u>

1. Shut off elevators whenever possible.

   Hospital officials prefer the elevators to be left on.

2. Shut off pneumatic tube system whenever possible.

   NA - Removed from scope.

3. Install capacitors or synchronous motors to increase power factor.

   NA - Removed from scope.

4. Use emergency generator to reduce peak demand.

   NA - Removed from scope.

5. Shed or cycle electrical loads to reduce peak demand.

   Shedding electrical loads by using emergency generators is already in effect.

6. Balance loads.

   NA

7. Reduce transformer losses by proper loading and balancing.

   NA - Removed from scope.

8. Convert to energy efficient motors.

   Existing electric motors are energy efficient.

9. Variable Volume Pumping

   This ECO is evaluated in ECO 2.

Plumbing

1. Reduce domestic hot water temperature.

   Domestic hot water is set at an acceptable level.

2. Repair and maintain hot water and steam piping insulation.

   Inspection of building piping insulation indicates that pipe insulation is presently acceptable and well maintained.

3. Install flow restrictors.

   Flow restrictors are currently being utilized.

4. Install faucets which automatically shut off water flow.

   Building officials indicate that manual shut off of faucets is effective and savings will not be realized.

5. Decentralize hot water heating.

   Because piping is presently well insulated and maintained, decentralization will not reduce energy requirements.

6. Add pipe insulation.

   All pipes are currently well insulated.

Kitchen

1. Shut off range hood whenever possible.

   The kitches staff currently shuts off range hood when meals are not being prepared.

2. Install high efficiency steam control valves.

   Evidence of steam losses due to leaking valves in the kitchen area does not indicate energy savings potential.

3. Shut off equipment and appliances whenever possible.

   All kitchen equipment is currently shut off by kitchen staff when not in use.

4. Install make up air for exhaust.

   Make up air is presently supplied for kitchen exhaust hoods. No retrofit is applicable.

5. Install heat reclamation system for exhaust heat.

   Exhaust hoods are small and do not exhaust excessive heat, use of heat reclamation equipment is therefore not applicable. A heat wheel was considered, since air must be exhausted from the kitchen area, but found not to be available for systems of this size.

6. Turn off lights in coolers.

   The kitchen staff currently shuts off cooler lights when not in use.

7. Water heating heat pump.

   Water heating heat pumps can heat water up to 140^{O}F and simultaneously provide "free cooling", but the hot water supplied to the kitchen is preheated to 115^{O}F, which would account for only a 25^{O}F increase in temperature. With only a 25^{O}F change in temperature, the amount of cooling provided would be minimal and therefore net savings would be slight, if any.

   All possible scenarios for using a heat pump water heater were discussed with the equipment manufacturer. The manuafacturer does not recommend use of a heat pump water heater at this facility since actual savings will be minimal.

Miscellaneous

1. Install incinerator and heat recovery system.

   NA - Removed from scope.

2. Install computerized energy monitoring and control system (EMCS).

   NA - Removed from scope. (Presently being installed)

3. Convert steam driven turbine to electric motor.

   NA - Removed from scope

4. Occupancy sensors to control lighting or HVAC.

   Building officials indicate that manual operation of lighting is in effect, and heating, ventilating and air conditioning setback is provided for in EMCS.

ATTACHMENT B

ANALYZED ECOs

MEASURE	ENERGY MBTUs	SAVINGS DOLLARS	TOTAL INVESTMENT	SIR	PAYBACK
ECO 1 Reset T'stat Setting AC-10	NOT RECOMMENDED				
ECO 2 Variable Speed Pumping	1,879.91	$24,232	$ 69,300	2.99	2.9
ECO 3 Two Speed Clg Tower Fan Motors	258.67	$ 3,334	$ 7,939	3.59	2.4
ECO 4 Double Pane Windows	201.27	$1,271	$ 30,156	0.45	23.7
ECO 5 Reduce OSA AC-11, 13, 14	81.40	$ 561	$ 3,197	1.82	5.7
ECO 6 Reduce OSA to OR	VIOLATES TM-5-832-2 AND IS THEREFORE NOT ANALYZED.				
ECO 7 Convert Dual Duct to VAV	1,640.53	$19,590	$106,861	1.60	5.5
ECO 8 Convert Multi Zone to VAV	1,211.50	$12,377	$132,784	0.85	10.7
ECO 9 Setback OR, Delivery	288.86	$ 1,909	$21,515	0.94	11.3
ECO 10 Reduce Supply Air - AC-3	473.43	$ 6,103	$ 7,868	6.62	1.3

ATTACHMENT B

ANALYZED ECOs

MEASURE	ENERGY MBTUs	SAVINGS DOLLARS	TOTAL INVESTMENT	SIR	PAYBACK
ECO 11 Automatic Tube Cleaners	104.64	$ 1,349	$ 14,213	1.00	8.6
ECO 12 Chiller Aux. Condenser	1,103.16	$ 5,759	$ 21,870	3.86	3.8
ECO 13 Reset All Thermostats (Recommended as policy change)	1,088.10	$ 14,170	$ 101	932.33	0.01
ECO 14 Window Shading	170.63	$ 1,056	$ 5,943	1.39	5.6

ATTACHMENT C

RECOMMENDED ECOs
RANKED BY SIR

MEASURE	ENERGY MBTUs	SAVINGS DOLLAR	TOTAL INVESTMENT	SIR	PAYBACK
ECO 13 Policy Change Reset Thermostats	1,088.10	$14,170	$ 101	932.33	0.01
ECO 10 Reduce Supply Air - AC-3	473.43	$6,103	$ 7,868	6.62	1.3
ECO 12 Chiller Aux Condenser	1,103.16	$5,759	$ 21,870	3.86	3.8
ECO 3 Two Speed Clg Tower Fan Motors	258.67	$3,334	$ 7,939	3.59	2.4
ECO 2 Variable Speed Pumping	1,879.91	$24,232	$ 69,300	2.99	2.9
ECO 5 Reduce OSA AC-11, 13, 14	81.40	$561	$ 3,197	1.82	5.7
ECO 7 Convert Dual Duct to VAV	1,640.53	$19,590	$106,861	1.60	5.5
ECO 14 Window Shading	170.63	$1,056	$ 5,943	1.39	5.6
ECO 11 Automatic Tube Cleaners	104.64	$1,349	$ 14,213	1.00	8.6
TOTALS	6,800.47	$76,154	$237,290	2.86	3.1